THE ENBRIDGE CONSUMERS GAS "STEAM SAVER" PROGRAM ("AS FOUND" PERFORMANCE AND FUEL SAVING PROJECTS FROM AUDITS OF 30 STEAM PLANTS)

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ABSTRACT

In Canada, medium and large sized steam plants consume approximately 442 Billion Cubic Feet (12.5 Billion Cubic Metres) of natural gas annually. This is 25% of all natural gas delivered to all customers. (Small steam plants and Hydronic heating boilers consume another 15%)

Enbridge Consumers Gas, a local gas distribution company located in Toronto, has approximately 400 Industrial and Institutional customers who own medium or large sized steam plants.

During the past three years, Enbridge has developed a comprehensive steam energy efficiency program called **"Steam Saver".** This program is aimed at these 400 customers. The heart of this program is the boiler plant audit and performance test.

This paper describes the fuel saving results for more than 30 medium and large sized boiler plants where audits have been completed and projects have been implemented.

The savings in cubic feet per year of natural gas are broken down according to project or technology type. The financial payback is indicated for each category.

Eleven of the larger plants have been "benchmarked". Plant efficiency, fuel consumption, steam costs and other performance variables are tabulated for these plants.

INTRODUCTION

Enbridge Consumers Gas is a natural gas distributor whose franchise service area includes the Greater Toronto area, Ottawa , Eastern Ontario and the Niagara Penninsula. We have 1.4 million customers including 1200 Large Volume customers.

In 1994, for the first time, the Ontario Energy Board required the two main gas utilities in this province to implement energy efficiency programs in all markets. In 1997, Enbridge Consumers Gas introduced the "Steam Saver" boiler plant audit which is aimed at large volume industrial and institutional customers having steam plants.

Since 1997, 30 steam plants have been audited and 1.1 Billion Cubic Feet (33 Million Cubic Metres) of energy saving opportunities have been identified. This represents 14% of the total natural gas consumed by these plants.

In 1999, several **new programs** were introduced to focus on other opportunities to save steam energy. .These programs include Steam Trap Surveys, Steam Pressure Reduction, Combustion Tune-ups and Plant Metering. These new programs have identified further savings.

The role of the gas utility is to facilitate the identification and implementation of fuel saving projects. We are in a unique position to do this by virtue of our existing sales force, knowledge of the market, equipment suppliers and our reputation for providing un-biased technical assistance.

The business strategy of Enbridge is to :

(1.) Employ the existing sales force (12 Energy Management Consultants) to sell energy efficiency projects directly to customers.
(2.) Provide customers and our own EMC's with detailed technical education on steam and boilers by means of regular third party training sessions.
(3.) Work with outside engineering consultants and customers to sell, organize and participate in boiler plant audits and other projects.
(4.) Develop steam efficiency programs.
(5.) Provide Incentive Grants to encourage project implementation.

(6.) Provide competitive lease financing to our customers.

THE STEAM BOILER POPULATION

Ontario is the most heavily Industrialized province in Canada. With a population of 12 million people and an industrial base of some 5000 manufacturing companies (larger than 50 employees) it can be compared in size and industrial output with Michigan or Ohio.

All major industrial sectors are represented. The automotive, pulp and paper and steel industries are particulary large energy and steam users. Food and beverage processors and the Petrochemical industry are also heavy steam consumers.

The Enbridge Consumers Gas franchised service area area includes approximately one third of the Province's industry and half of its large institutions.

The Enbridge Steam Saver program is aimed at Industrial customers and also medium and large sized institutions such as Hospitals, Defense Bases and Universities. These facilities have Central Heating Plants which are increasingly moving to co-generation to supplement steam production and absorption chilling to level out the seasonal steam demand

TABLE 1

BOILER POPULATION FOR STEAM PLANTS WITH ANNUAL FUEL CONSUMPTION GREATER THAN 70 MILLION CUBIC FEET (2 MILLION CUBIC METRES) OF NATURAL GAS

	No. of Boilers	No. of Plants	Annual Gas Consumption BCF/YR	Annual Gas Consumption B CU M/YR
ENBRIDGE AREA	1,330	400	66 BCF/YR	1.9 B CU M/YR
ONTARIO	4,000	1,200	177 BCF/YR	5.0 B CU M/YR
CANADA	10,000	3,000	442 BCF/YR	12.5 B CU M/YR

Note: All figures exclude large electric utility plants. BCF/YR = Billion Cubic Feet per Year
B CU M/YR = Billion Cubic Metres per Year

FUEL CONSUMPTION IN BOILER PLANTS

While the focus of Enbridge's efforts to improve efficiency in steam plants is natural gas, steam efficiency can equally be applied to plants which burn other fuels. Any of the efficiency programs described here can be applied to oil, wood or coal fired plants.

In Ontario, fuel consumption in the target market (medium and large steam plants) breaks down approximately as follows:

TABLE 2

FUEL CONSUMED BY MEDIUM AND LARGE BOILER PLANTS-ONTARIO

	Equivalent BCF	% of Total
Natural Gas	177	65%
Oil	50	18%
Wood	40	15%
Coal/other	5	2%
Total	**272**	**100%**

Note: Most plants burning wood co-fire with natural gas.

Most oil is consumed by customers with interruptible gas contracts operating under gas curtailment conditions.

THE "STEAM SAVER" PROGRAM

The Regulatory and Financial Background.

The Ontario Energy Board (O.E.B.) is the regulating agency for the two gas utilities and the electric utiliies in this Province. In 1994, the O.E.B. required the gas utilities to implement energy efficiency programs for all market sectors. In 1999, the O.E.B. and Enbridge negotiated a special financial arrangement called the " Shared Savings Mechanism". This arrangement sets targets in terms of natural gas volumetric savings which must be implemented by Enbridge each fiscal year. If Enbridge fails to meet the annual target, it pays a heavy financial penalty which is levied through the rate base. On the other hand, if we exceed the target, we receive a significant financial reward by the same means. The penalty or reward is directly proportional to the energy efficiency volume shortfall or excess compared to the target figure. The formula for calculating the penalty or reward is complex. In general it is based on the estimated societal benefits attributable to saving a cubic metre of natural gas in terms of dollars, saved emissions, avoided infrastructure costs and so on. Our share of the total benefit is a percentage of the total figure. This arrangement has provided a major financial incentive for Enbridge to implement energy efficiency programs.

The Steam Saver Program Described

The Steam Saver Program began in 1997 as a single activity, the steam plant audit and performance test. It has since been expanded to include specific programs designed to achieve savings sooner, for smaller customers and at less cost. The performance test and audit is still the largest activity but programs such as **the Steam Trap Survey** is generating rapidly growing results. A new program **The Combustion Tune-up Program**, has received an excellent early response from customers. Exhibit 1 attached to this paper provides an overview of the various programs.

The Steam Plant Performance Test and Audit

Why Do a Boiler Plant Audit?

The purpose of the steam plant performance test and audit is:

- To identify fuel savings opportunities
- To provide useful operating and economic data to the customer (Benchmarking)

Who Qualifies for an Audit?

All customers having boiler plants which consume more than 2 million CU M/YR (70 million CU FT/YR) or more of natural gas qualify.

Who is Responsible for the Audit?

After the Enbridge Energy Management Consultant (EMC) sells an audit to a customer he assumes the project responsibility for organizing the field work and coordinating the report.

We contract outside specialized Steam Engineering Consultants to do the audit but participate in the testing and site work. Enbridge supplies and maintains combustion analyzers and other test equipment.

How is an Audit Done?

The audit field work and report proceed according to a standard format (which can be tailored for specific customer requirements and circumstances). Here is the standard procedure and report format which has been developed over three years:

(1.) Field Work First.

This is a crucial part of the process. The auditors must establish a friendly relationship with the plant management and operators. There is often an air of suspicion in boiler plants because of the fear of criticism or job loss. The watchword here is diplomacy.

The Enbridge EMC spends two or three days in the customer's plant with the outside engineering consultant.

Combustion Tests are done on all boilers taking combustion and temperature readings at four or five points between low and high fire.

The boiler plant is inspected with a view to identifying problems or losses. Features such as economizers, air pre-heaters, blow down heat recovery, excessive venting and instrumentation are all considered.

(1.) Field Work First.
The boiler plant supplies its records to the auditors. This may include a wide variety of daily or monthly operating reports, operators logs, water treatment records and even previous test reports. Many plants have very poor records or almost none at all.

(2.) The Audit Report
The audit report is completed by the steam consulting engineer together with the Enbridge EMC who usually writes part of the report.

The standard report comprises eight sections as follows:

Executive Summary-a listing of energy saving opportunities complete with savings and capital cost estimate.

Section 1-Plant Energy History
A summary of operating data for the past year. We rely heavily on the hourly gas consumption information from the utility gas meter (The Metretek System). Combustion test results and steam plant log data are also employed. The result is a comprehensive report on fuel consumption, steam production, peaks and averages, blow down rate, water make-up, electricity and so on.This section also includes cost data and benchmarking for the larger plants.

Section 2-Equipment List
Nameplate and rating data from all boilers and other major equipment in the plant.

Section 3-Combustion Test data
Calculation of losses using the ASME power test code method and efficiency graphs for all boilers.

Section 4-Plant Inspection Report
Observations and comments on the plant design, equipment condition and suggestions for improvements to save energy

Section 5-Steam Loads and Distribution
Observations about the steam distribution system and comments on the nature of loads. Spot obvious opportunities to save such as excessive venting of condensate receivers, condensate not returned, un-insulated piping and so on.

Section 6-Water Treatment
A general review of the water treatment records. Comments on blow-down, maintaining target levels of sulphite, PH and alcalinity.

Section 7-Savings and Capital Cost
Calculations showing the savings estimates for each project.

Section 8-Safety Issues
Comments on conditions such as high Carbon Monoxide levels in flue gas, natural gas leakage and steam leakage.

THE COST OF DOING A STEAM PLANT PERFORMANCE TEST AND AUDIT
The following is the average direct cost of 30 audits completed to date. It excludes administrative and marketing costs.

Steam Engineering Consultant Fee	$7,650
Travel Expenses	$ 600

Enbridge EMC's Time	$ 4,250
Total	**$12,500**

Note: The Average Hourly Rate is $ 85/HR.

Enbridge pays two thirds of the Consultant Fee to a maximum of $ 4,000. On average therefore, Enbridge pays the maximum of $4000 the customer pays $ 2,650 for the audit

RESULTS OF 30 STEAM PLANT PERFORMANCE TESTS AND AUDITS

The results of 30 steam plant audits performed since 1997 are shown in table 3 below. 20 of the audits were industrial customers one brewery, three paper mills, one rubber manufacturer, two textile plants and four food and beverage facilities. The remaining 10 customers were Central Heating Plants in hospitals, universities, one national defense base and one federal government research complex.

TABLE 3
TOTAL RESULTS OF STEAM PLANT PERFORMANCE TESTS AND AUDITS
EXCLUDING NEW PROGRAMS FOR 1999

No. Plants Audited	30	
Annual Gas Vol. Consumption	8.52 Billion CU FT/YR	241.3 Million CU M/YR
Annual Gas Bill	$ 27.8 Million	
No. of Savings Projects Identified	158	
Annual Fuel Savings Identified	1.17 Billion CU FT/YR	33.1 Million CU M/YR
Annual Dollar Savings Identified	$ 4.3 Million	
Savings % of Annual Gas Bill	15.5%	
Capital Cost of Projects Identified	$ 10.5 Million	
Average Payback of Projects Identified	2.4 Years	
No. of Savings Projects Implemented	32	
Annual Gas Vol. Savings Implemented	218 Million CU FT/YR	6.2 Million CU M/YR
Annual Dollar Savings Implemented	$ 992 Thousand	

WHERE DO THE SAVINGS COME FROM?

Table 4 (next page) provides a breakdown of the results of the steam plant audits and other programs by type of project.

Heat Recovery Pojects (3.7% of total fuel can be saved)

New economizers, blow-down heat recovery and condensing heat recovery projects identified the largest single category of improvement. The potential payback of 2.3 years is very attractive
The top projects in terms of savings identified are:

Boiler Room Capital Projects (2% of total fuel can be saved)

Despite the long payback, (7.5 years) boiler replacements and new boiler plants proceed on the basis that a facility must have adequate steam supply. Enbridge's role in affecting energy savings is to work with customers who are making these investments at the planning stage in order to provide technical and financial assistance to optimize efficiency. Boiler sizing and selection, heat recovery and other decisions come to play.

Steam Distribution System Improvements and Trap Repair (2.5% of total fuel can be saved)
Trap repairs, replacement, improved condensate return and other projects are an attractive investment with an average simple payback of 1.2 years. The savings figure above is likely understated because this area was not targeted by the Steam Saver Program until relatively recently. Combustion Improvements (1.6% of total fuel can be saved)
Combustion improvements are almost universally required. The payback on projects such as boiler tune-up, repair of burners, fuel air ratio components and blowers is less than one year.

TABLE # 4
STEAM SAVER PROGRAMS
SUMMARY OF RESULTS BY TYPE OF PROJECT

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Dec. 31, 1999

TYPE OF PROJECT	IDENTIFIED SAVINGS					PROJECTS IMPLEMENTED	
	NO. OF PROJECTS IDENTIFIED	ANNUAL DSM SAVINGS CU M / YR	ANNUAL SAVINGS $	TOTAL CAPITAL INVESTMENT	AVERAGE PAYBACK YEARS	ANNUAL SAVINGS CU M/YR	ANNUAL SAVINGS $ / YR
Combustion Improvements Boiler Tune-up, Combustion control repair, Burner repair Repair existing oxygen trim system	30	4,363,104	$582,820	$537,900	0.92	1,530,223	$204,406
Boiler Room Capital Projects Replace old boiler, Add summer Boiler, Change feed-water pump, New feedwater system, New de-aerator New flue gas uptake damper, Turbine repair Add new automatic blow-down controller.	26	4,985,807	$615,022	$4,598,300	7.48	1,859,368	$229,362
Heat Recovery and Economizer Projects Add new economizer, Repair existing economizer Add new condensing heat recovery economizer Add new blow down heat recovery system.	24	10,246,804	$1,473,531	$3,344,020	2.27	1,118,810	$160,889
Capital Improvements to Process Equipment New control valves, New control system for pasteurizer	3	701,000	$91,145	$175,000	1.92	0	$0
Operating Changes in Boiler Room Reduce Deaerator venting, Reduce boiler blow-down Shut down boilers on weekends and off-hours Use existing F.W. turbine, Fewer boilers operating	19	2,407,192	$310,683	$65,732	0.21	646,621	$83,456
Steam Distribution Piping and Condensate Improvements (Excluding Steam Trap Program) New steam piping, New condensate piping and receivers, Consolidate steam piping of different pressures, Repair condensate pumps, New control Valves, Recover flash steam from tanks	30	5,528,910	$615,757	$621,500	1.01	938,970	$104,573
Building HVAC Changes and Capital Projects New Air handler controls, New Temperature set back controls Close building doors in winter, Turn off steam heaters in summer	7	2,485,990	$322,368	$490,000	1.52	0	$0
Metering and Monitoring Install new steam, gas, water meters. Repair and Calibrate existing	7	1,038,528	$131,364	$328,101	2.50	100,000	$12,649
Insulation Improvements Insulate oil storage tanks, Insulate steam piping	3	885,650	$115,322	$286,000	2.48	0	$0
Other Projects Clean boiler waterside, Improve water treatment, Clean heat exchangers	9	405,000	$52,816	$75,000	1.42	0	$0
TOTAL	**158**	**33,047,985**	**$4,310,828**	**$10,521,553**	**2.44**	**6,193,992**	**$795,335**
Steam Pressure Reduction Central Heating Plants	6	1,814,490	$290,318	$0	0.00	1,814,490	$290,318
Steam Trap Survey Program	6	1,288,670	$208,678	$274,500	1.32	537,280	$87,003
New Boiler Plant Program	2	525,000	$70,875	$1,307,352	18.45	400,000	$54,000
Metering and Monitoring Program Install new steam, gas, water meters. Repair and Calibrate existing Install computerized data acquisition system	2	476,000	$72,960	$185,000	2.54	476,000	$72,960

RESULTS BY CUSTOMER (Table 8)

Table 8 at the end of the paper shows details of Steam Saver program results by customer. This provides some insights into the nature of the market which has been part of the program and the cycle of implementation of projects which have been identified.

NEW STEAM SAVER PROGRAMS

Several new Steam Saver programs were introduced in 1999. The purpose was to take advantage of the findings of the Steam Plant Audits, which are summarized in Table 4. That is, to target the main savings areas without having to conduct an expensive study of the boiler plant. This also allows Enbridge to extend the Steam Saver Program to smaller plants.

The Steam Trap Survey

The steam trap manufacturers have considerable technical expertise in the application and testing of steam traps. Many steam distribution systems are poorly designed and maintained, resulting in major losses of energy in steam and condensate.

Our approach has been to team up with the steam trap manufacturers, initially Spirax Sarco, to conduct steam trap surveys.

Enbridge funds 50% of the survey cost. The Survey is conducted by Spirax Sarco technicians.

This includes tagging all traps, testing all traps and providing a critique of the system design problems where applicable.

Besides leaking traps, there are a range of common problems found:

- Condensate return pump failure, condensate dumping to drain.
- Condensate return lines too small causing back-up of condensate into coil or heat exchanger.
- Wrong type of trap for the application, oversized or undersized tramps.
- No strainers.
- Missing piping insulation.

TABLE 5
Early Results of Steam Trap Surveys

No. of Sites Surveyed	6
No. of Traps Tested	1590
No. of Leaking traps	187
% of Traps Found Leaking	12%
Annual steam Losses	24,319,000 LB/YR
Identified Fuel Savings	$ 208,678
Capital Investment	$ 274,500
Average Simple Payback	1.3 Years
Projects Implemented	2
Savings Implemented	$ 87,003

The Steam Pressure Reduction Program
This program is aimed at Central heating Plants where steam is produced at 100 or 150 PSIG, and transmitted to remote locations and reduced in pressure to 15 PSIG or lower.

Theoretically, energy is saved when the main steam pressure is reduced because:

- The boiler stack temperature is reduced.
- Piping radiation losses are reduced
- Leaks in traps and other sources are reduced.

The success of this measure depends on the fact that most Central Heating Plants are oversized . Boiler tubes and steam piping can accommodate the increase in the specific volume of the steam without un-due pressure loss. We have conducted initial tests at six plants and are now monitoring the benefits over a longer period. The true savings have ranged from 3% of the total gas consumption to 8% in one case. It appears that savings are greatest only when the pressure is reduced below 70 PSIG. Details of this program are available by contacting the author.

The New Boiler Plant Program
The boiler population is aging. In Ontario, records indicate that the average age of registered steam boilers is 26 years.
Most new boilers sold are for replacement, although there are still some greenfield boiler plant projects.

Many replacement boilers are installed without proper analysis, planning or attention to energy efficiency features.

The Enbridge New Boiler Program is designed to motivate owners to plan properly and consider energy saving features. This program provides financial incentives to companies who plan to install new or replacement boilers if they include the following package of energy efficiency measures:

(1.) Right Sizing the Boilers
In the past, boiler plants were much oversized by design. This was justified on the basis of future growth. Many plant owners are now paying a high penalty for the added losses of operating the boiler plant on low fire.

Enbridge offers technical help to customers in sizing based on load analysis and fuel consumption history. We have unique expertise in forecasting plant and heating loads and apply this experience at no charge to customers who are planning replacement or expansion of boiler plants.

(2.) Economizers
Economizers can improve annual boiler efficiency by as much as 5% however, an engineering analysis which takes account of the load profile is required to correctly estimate the savings attributable to the additional investment required to install an economizer.

(3.) Blow Down Heat Recovery
Part of the New Boiler Plant package is to consider implementing blow-down heat recovery in the new boiler plant.

(4.) Fuel and Steam Metering
One of the most neglected areas of the boiler plant is metering. New plants are encouraged to invest in steam and fuel metering, This is part of the incentive package offered to owners of new boiler plants.

The Boiler Combustion Tune-Up Program
Unnecessary combustion losses account for nearly 2% of the total fuel consumed by steam boiler plants. There is an existing infrastructure of boiler service companies who are capable of testing and repairing boiler combustion problems.

This program is designed to encourage steam plant owners to maintain the combustion of their boilers through their present boiler service companies or to do it themselves.

Enbridge has designed a program which pays the owner to test and tune-up his boilers twice per year.

The terms of this program are that the owner must submit combustion test results in order to be paid. The incentive grant is:

$ 150 per boiler per tune-up for boilers smaller than 600 Boiler Horsepower

$ 250 per boiler per tune-up for boilers 600 boiler horsepower and larger.

Metering and Energy Management for Boiler Plants.

Metering of fuel and steam is an often neglected aspect of steam plant operation. The boiler plant should be regarded by corporate management as a cost centre.

Fuel is 80% of the cost of operating a boiler plant .
It is imperative in most that the fuel input to the boiler plant be reported regularly. This is a bare minimum for responsible cost management, yet this requirement is often not met.

Low cost data acquisition systems make it feasible to automatically collect fuel consumption and other boiler plant data and produce regular reports for management use.

The average cost of operating a large boiler plant according to Steam Saver Audits of manned plants is over $3 million per year.

Enbridge offers incentive grants to steam plant operators who are prepared to install metering and energy management systems.

TABLE 6
TOTAL RESULTS OF THE STEAM SAVER PROGRAM
INCLUDING NEW PROGRAMS FOR 1999

Total No. of Plants	41	
Annual Gas Vol. Consumption	9.862.1 Billion CU FT/YR	279.3 Million CU M/YR
Annual Gas Bill	$33.3 Million	
No. of Savings Projects Identified	174	
Annual Fuel Savings Identified	1.309 Billion CU FT/YR	37.1 Million CU M/YR
Annual Dollar Savings Identified	$ 4.9 Million	
Savings % of Annual Gas Bill	14.7%	
Capital Cost of Projects Identified	$ 12.3 Million	
Average Payback of Projects Identified	2.5 Years	
No. of Savings Projects Implemented	43	
Annual Gas Vol. Savings Implemented	331.8 Million CU FT/YR	9.4 Million CU M/YR
Annual Dollar Savings Implemented	$ 1.3 MILLION	

CONCLUSIONS

In the past three years, The Steam Saver Program has demonstrated that on average, fuel savings of 14.7% of total annual fuel consumption can be achieved. The 174 projects in 41 plants have shown an average payback of 2.5 years.

43 of these projects saving 331.8 million cubic feet (9.4 million cubic metres) of natural gas annually have been implemented. This represents 4% of total fuel consumption.

Enbridge customers are saving $ 1.3 million annually on these projects.

The rate at which savings are identified and implemented is growing rapidly. This is due to:

- The growing effectiveness of the Enbridge Energy Management consultants.
- The long selling cycle. Capital projects require an average of 18 months to proceed. There are more projects in the pipeline after three years.
- The rapid rise in natural gas prices which has motivated plant owners to better manage their energy costs.

New programs which were introduced in 1999 and designed to accelerate the process of implementing energy saving projects are beginning to show results.

The best projects for saving energy in a steam plant are:

- Combustion improvements.
- Heat recovery projects.
- Steam Trap and Distribution System maintenance and repair.
- Boiler replacement with proper sizing, selection and metering.

Plant benchmarking is a useful tool for management to guage their operation. The average cost of steam for 11 large steam plants is $ 8.25 per thousand LB. Table 7 on the next page gives details of the benchmarking project.

BENCHMARKING STEAM PLANTS FROM STEAM SAVER AUDIT DATA

Table 7 below provides a summary of the data and results from Steam Saver Audits of 11 plants. These are all manned boiler plants and represent the larger end of the size scale. Every customer who purchases a boiler plant audit is provided with a cost and performance comparison which shows his plant vs. the average. This is useful information for management and can be used to motivate improvements.

TABLE # 7

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BENCHMARKING PROJECT
AVERAGE COST AND PERFORMANCE
11 LARGE BOILER PLANTS

			AVERAGE OF ALL SITES		ABC MANUFACT-URING INC.	
1	Date of Audit		1997 to 1999		1999	
2	Type of Steam Load		Heating and Process		Process	
3	Installed Boiler Capacity	(LB/H)	**182,400**		**216,400**	
4	Rated input of "ON" boilers	(BTU/HR)	**113**		**197**	
5	Annual Gas Consumption	(MILLION CU M))	**15.7**		**18.6**	
	includes equivalent btu value of oil	(MILLION CU FT)	**554.4**		**656.7**	
6	Average Hourly Gas Cons.	(CU M/HR)	**1,860**		**2,201**	
		(CU FT/HR)	**65,676**		**77,717**	
7	Peak Hourly Gas Consumption	(CU M/HR)	**3,309**		**3,841**	
		(CU FT/HR)	**116,841.0**		**135,625**	
8	Operating Hours /YR		**8,643**		**8,430**	
9	Average combustion Efficiency (%)		**82.8%**		**81.4%**	
10	Average Plant Efficiency (%)		**76.8%**		**78.1%**	
11	Operating Pressure (PSIG)					
12	Total enthalpy at operating pressure					
13	Steam net added Enthalpy for Site (BTU/LB)		**1,063**		**1,075**	
14	Annual Steam Production (LB)		**411,605,892**		**562,829,976**	
15	Average Hourly Steam Production (LB/HR)		**47,701**		**66,122**	
16	Peak Hourly Steam Load (LB/HR)		**86,889**		**99,993**	
17	Make-up Water Annual Consumption	(Million US GAL)	**22**		**30.4**	
18	Electricity Annual Consumption (KWH/YR)		**918,712**		**1,617,280**	
19	Average Blow-down Rate		**5.61%**		**4.0%**	
20	Blow-Down Heat Recovery				**yes**	
21	Estimated Vent Losses (BTU/HR x 1000)		**280**		**200**	
22	Estimated Radiation and Unaccounted Loss		**2.00%**		**2.00%**	
	23 **STEAM COST**		**$ U.S. ANNUAL AVERAGE**	**$ U.S AVERAGE COST/KLB**	**$ U.S ANNUAL**	**$ U.S AVERAGE COST/KLB**
	24 Fuel At standardized cost of $ 3.17 U.S per 1000 CF		$1,763,021	4.283	$2,078,373	$3.693
Note:	If actual fuel costs are required, adjust to actual rate.					
	25 Electricity		$48,578	0.118	$67,925	$0.121
	26 Water		$32,189	0.078	$44,198	$0.079
	27 Water treatment chemicals		$25,732	0.063	$27,090	$0.048
	28 Operating Labour		$208,872	0.507	$230,300	$0.409

29	**TOTAL OPERATING COST**	**$2,078,392**	**$5.049**	**$2,447,886**	**$4.349**
30	**MAINTENANCE COSTS**				
31	Mtce. Labour				
32	Mtce Parts				
33	**SUB-TOTAL MAINTENANCE COST**	$198,166	$0.481	$89,500	$0.159
34	**TOTAL ANNUAL OPERATING COST**	**$2,276,558**	**$5.531**	**$2,537,386**	**$4.508**

NOTES: 1. Fuel costs have been normalized to $ 0.16 per cubic Metre of Natural gas or $ 4.55 per M CF of natural gas
2. Oil consumption is included in fuel costs. This is less than 2% of the total in the time period surveyed
3. Maintenance costs have low accuracy. Few steam plant owners keep accurate records of this cost.
4. The plant efficiency calculation includes combustion losses, radiation losses, the effect of operating at low firing rates and an estimate of plant vent losses. It excludes losses in the steam distribution system.
5. Only the larger plants audited in the Steam Saver Program are included. Un-manned boiler plants are excluded.
6. Dollars are Canadian
7. Costs Exclude Administration, Interest and Depreciation Charges

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TABLE # 8
STEAM SAVER AUDITS
SUMMARY OF RESULTS BY CUSTOMER
BY CALENDAR YEAR

AUDIT NO.	CUSTOMER	AUDIT Date	ANNUAL GAS VOL CU M	ANNUAL GAS BILL	NO. OF PROJECTS	ANNUAL SAVINGS IDENTIFIED CU M	ANNUAL DOLLAR SAVINGS IDENTIFIED	CAPITAL Investment	PROJECTS IMPLEMENTED GAS SAVINGS IN CU M/YR 1997	1998	1999 Year to Date Dec. 31, 1999	
	BOILER PLANT AUDIT PROGRAM											
1	Aircraft Manufacturer	May, 1997	6,640,953	$753,579	9	3,041,722	$301,968	$226,000				
2	Food Processor	July, 1997	9,754,672	$1,215,862	4	1,527,766	$191,000	$560,000		258,810	1,157,492	
3	Food Processor	Aug., 1997	2,783,845	$318,943	4	994,715	$121,894	$153,000			178,000	
4	Brewery	Aug., 1997	9,088,533	$881,308	5	1,928,600	$187,256	$299,101		656,754		
5	Textile Manufacturer	Aug.,1997	1,040,522	$146,382	6	181,947	$29,100	$96,600		103,500	100,000	
6	Cigarette Manufacturer	Sept., 1997	1,867,590	$198,338	5	511,270	$54,296	$180,000				
7	Glass Manufacturer	Sept., 1997	2,743,095	$359,592	4	430,037	$56,373	$92,000				
8	Textile Manufacturer	Sept.,1997	3,045,272	$339,998	6	1,950,619	$254,405	$451,000				
9	Chemical Refinery	Dec. 1997	16,219,263	$1,459,734	6	1,051,200	$96,640	$288,300				
10	Rubber Manufacturer	Oct. 1997	2,850,475	$365,068	8	657,376	$105,025	$270,000	657,376			
11	Paper Mill	April,1998	13,551,124	$1,422,868	3	964,270	$101,288	$170,000				
12	Pharmaceutical Manufactuer	Aug.,1997	1,813,601	$244,719	4	481,552	$63,876	$27,000		137,461		
13	Sugar Refinery	Nov., 1997	44,951,097	$4,587,709	7	1,891,890	$193,108	$626,000		232,068		
14	Electronics Manufacturer	Mar., 1998	2,666,933	$293,400	3	298,363	$327,800	$125,000				
15	University	Apr., 1998	10,760,312	$1,085,059	5	1,315,182	$89,522	$126,000				
16	Canadian Forces Base	Mar., 1998	10,201,633	$1,224,220	4	796,332	$95,800	$77,500			400,000	
17	Greenhouse	Apr., 1998	2,023,603	$294,317	6	449,831	$57,100	$105,500				
18	Toy Company	Apr. 1998	462,000	$58,145	2	333,333	$55,000	$135,000			101,000	
19	Hospital	June, 1998	10,272,061	$956,190	6	787,494	$73,237	$275,000			177,419	
20	Hospital	May, 1998	1,500,330	$214,300	6	197,231	$27,860	$112,600				
21	Hospital	Nov., 1998	4,087,737	$617,248	4	713,896	$107,798	$687,501			330,000	
22	Paper Mill	Jan., 1999	34,801,564	$3,473,944	4	1,241,369	$127,861	$251,000			220,000	
23	Food Processor	April, 1999	973,351	$142,210	8	408,394	$59,667	$790,000				
24	Hospital	June, 1999	1,496,000	$256,362	6	307,240	$52,660	$109,000			223,469	
25	Hospital	June, 1999	1,028,506	$159,251	6	177,034	$27,460	$47,200				
26	Laundry	April, 1999	1,948,381	$286,488	8	946,960	$139,203	$89,000			207,134	
27	Univeristy	May, 1999	8,792,517	$1,216,005	3	411,971	$55,832	$450,000				
28	Federal Government Agency	May, 1999	3,856,000	$501,280	5	1,381,882	$179,645	$223,000				
29	Food Processor	Dec. 1999	8,701,000	$1,305,150	6	2,880,623	$312,093	$304,251			253,509	
30	Paper Mill	Sept., 1999	21,355,000	$3,416,000	5	4,787,886	$766,061	$3,175,000			800,000	
	SUB-TOTAL		**241,276,970**	**$27,793,669**	**158**	**33,047,985**	**$4,310,828**	**$10,521,553**	**657,376**	**1,388,593**	**4,148,023**	**6,193,992**
	STEAM PRESSURE REDUCTION PROGRAM											
31	Hospital	Sept. 1998			1	140,000	$22,400	$0			140,000	
32	Federal Government Agency	July, 1999			1	150,000	$23,500	$0			150,000	
33	University	Apr., 1998			1	991,400	$99,980	$0		991,400		
34	Electronics Manufacturer	Mar., 1998			1	109,090	$12,000	$0		109,090		
35	Hospital	Nov. 1998			1	200,000	$30,000	$0			200,000	
36	Canadian Defense Base	Sept. 1998			1	224,000	$31,300	$0			224,000	
	SUB-TOTAL				**6**	**1,814,490**	**$219,180**	**$0**		**1,100,490**	**714,000**	**1,814,490**
	STEAM TRAP SURVEY PROGRAM											
37	Food Processor	April, 1999	15,000,000	$2,250,000	1	410,194	$65,631	$124,000			410,194	
38	Textile Manufacturer	April, 1999	2,000,000	$325,000	1	127,086	$20,333	$37,000			127,086	
39	Hospital	Oct., 1999			1	189,190	$32,162	$28,000				
40	Food Processor	Oct., 1999	11,000,000	$1,650,000	1	400,000	$64,000	$45,000				
41	Laundry	Sept, 1999			1	120,000	$19,800	$20,000				
42	Pharmaceutical Manufacturer	Oct. 1999	1,500,000		1	42,200	$6,752	$20,500				
			29,500,000	**$4,225,000**	**6**	**1,288,670**	**$208,678**	**$274,500**			**537,280**	**537,280**
	NEW BOILER PLANT PROGRAM											
43	Printing Plant	April, 1999	7,000,000	$910,000	1	400,000	$52,000	$1,132,352			400,000	
44	Paint Manufacturer	Mar., 1999	1,500,000	$320,000	1	125,000	$21,250	$175,000				
	TOTAL NEW BOILER PLANT		**8,500,000**	**$1,230,000**	**2**	**525,000**	**$73,250**	**$1,307,352**			**400,000**	**400,000**
	METERING AND DATA ACQUISITON PROGRAM											
45	University	Oct., 1999			1	20,000	$3,200	$35,000			20,000	
46	Federal Government Agency	Nov., 1999			1	456,000	$72,960	$150,000			456,000	
	TOTAL METERING AND DATA PROGRAM				**2**	**476,000**	**$76,160**	**$185,000**			**476,000**	**476,000**
	TOTAL ALL STEAM SAVER PROJECTS		**279,276,970**	**$33,248,669**	**174**	**37,152,145**	**$4,888,096**	**$12,288,405**	**657,376**	**2,489,083**	**6,275,303**	**9,421,762**